Experimental study of elastic band gaps in a three dimensional ultrasonic crystal

A.Khelif, A. Choujaa, S. Benchabane, and V. Laude,
Département LPMO, Institut FEMTO-ST, 32 avenue de l'Observatoire, F-25044
Besançon cedex, France.

A great deal of research effort is currently being devoted to the study of acoustic or elastic waves propagation in periodically structured materials, such as the so-called phononic crystals. These are made of two- or three dimensional periodic repetitions of different solids or fluids which exhibit absolute stop bands in the transmission spectrum of acoustic waves. The location and width of these band gaps result from a large contrast in the value of elastic constants and/or mass density of the constitutive materials.

In this work, we report on the experimental observation of the existence of a full acoustic band gap in a three dimensional crystal, consisting of fcc arrays of close-packed steel beads in epoxy matrix. The choice of steel and epoxy as the composite materials is based on the strong contrast in their densities and elastic constants. The scatterers diameter is 4 mm and the filling fraction of the close-packed lattice is 74 %. For this arrangement, we measure a huge full band-gap extending between 300 kHz and 650 kHz (60% fractional bandwidth) in which elastic waves are not allowed to propagate in all directions. This makes this structure a potential candidate for designing new acoustic filters or insulators.